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TRILOBITES FROM THE MOUNT IDA FORMATION (LATE SILURIAN-EARLY DEVONIAN), VICTORIA

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Abstract: A poorly preserved fauna of sixteen trilobite species is described from coarse quartzose sandstones of the Mount Ida Formation in the Heathcote district of central Victoria. Most of the taxa are described under open nomenclature but two new species are named, *Scutellum droseron* and *Cheirurus (Crotalocephalina) oxina*. The trilobites support the view of Philip (1967), based on brachiopods, that Unit 3 of the Mount Ida Formation is of early Gedinnian age, whereas stratigraphic relations indicate that the lower part of the formation is of Pridolian age.

The stratigraphy of the Silurian-Lower Devonian sedimentary sequence in the Heathcote district of central Victoria was originally described by Thomas (1937) and has been summarised recently by VandenBerg & Garratt (1976) (Fig. 1). The Mount Ida Formation, the uppermost unit in the sequence, consists of approximately 2100 m of sandstones with interbedded mudstones, shales and conglomerates that were interpreted by Talent (1965a) as having been deposited in a shallow-water environment close to the western margin of the Melbourne Trough. The formation was subdivided by Thomas (1937) into four units, apparently largely on the basis of the poorly preserved shelly fauna which is dominated by brachiopods but also includes molluscs, trilobites, corals, bryozoans, and rare sponges, ostracodes and echinoderms. The faunas of Units 1 and 2 are small and characterized by the abundance of the brachiopods *Molongia* cf. *elegans* Mitchell and *Notoconchidium thomasi* Gill respectively; Unit 3 contains the most abundant and diverse faunas in the Heathcote sequence. No fossils have been found in Unit 4, which contains conglomerates.

With the exception of a short paper on two species of brachiopods (Gill, 1951), the only descriptions of the fauna of the Mount Ida Formation are in a monograph by Talent (1965b) on the faunas of the whole sequence. Since that work was published large collections of fossils have been made from the Mount Ida and these contain numerous trilobites, including several forms not previously recorded. Most of the trilobites described in the present study were obtained from Unit 3 of the formation; Units 1 and 2 have yielded only a few species (Table 1). The trilobites occur as internal and external moulds in hard, grey to brown or red quartzose sandstones that are so coarse-grained that fine morphological features of the exoskeleton have not been preserved. In addition, the surfaces of the moulds are commonly encrusted with a layer of iron minerals that further obscures detail. Partially or completely articulated specimens are very rare, and furthermore the isolated parts of the exoskeleton have commonly been broken prior to preservation. This, together with the fact that the associated brachiopods are all preserved with their valves separated, is indicative of transport and deposition in a turbulent environment.

AGE AND CORRELATION

Unit 3 of the Mount Ida Formation has always been considered to be of Early Devonian age but there has been disagreement about its precise correlation with standard European sequences. Owing to the scarcity of stratigraphically useful fossils in Units 1 and 2 and in the underlying McIvor Sandstone, there has also been considerable uncertainty as to whether the Silurian-Devonian boundary should be placed within the lower part of the formation, at its base, or even below it. Talent (1965a, b) considered the fossil assemblage of Unit 3 to be indicative of a broad Gedinnian-Siegenian age and placed the Silurian-Devonian boundary (Skalian-Gedinnian boundary in his 1965a correlation chart, although at that time he included the Skalian within the Devonian) somewhere within the McIvor Sandstone. Philip (1967) placed the boundary much higher, at the base of Unit 3 of the Mount Ida, which he considered to be of early Gedinnian age on the basis of the brachiopod fauna. A similar brachiopod fauna occurs in the upper part of the Boola Beds in the Tyers area (see Philip 1962, pp. 244-6) and also in the Maradana Shale in the Manildra district of New South Wales; the latter was considered to be of early Gedinnian age by Savage (1974). Unit 2 of the Mount Ida Formation was correlated by Philip (1967) with the upper part of the Florence Quartzite of Tasmania, which he regarded as pre-Gedinnian because of the presence of encrinurid trilobites (but see discussion below on the upper range of encrinurids). Strusz *et al.* (1972) equated the upper part of the Mount Ida Formation with strata in the Yea and Seymour districts containing *Monograptus thomasi* and *M. aequabilis notoaequabilis*, and from this concluded that Unit 3 is late Lochkovian (approximately late early to middle Siegenian). They placed the Silurian-Devonian boundary in the Heathcote sequence at the top of the McIvor Sandstone which was considered to be of Pridolian age because of the entry in that unit of the brachiopod *Notoconchidium*.

VandenBerg & Garratt (1976) stated that the upper part of the McIvor Sandstone laterally becomes the Clonbinane Sandstone Member of the Humevale Formation and that this unit contains *M. thomasi* and *M. aequabilis aequabilis* at the top. Consequently they regarded the upper part of the McIvor as Early Devo-

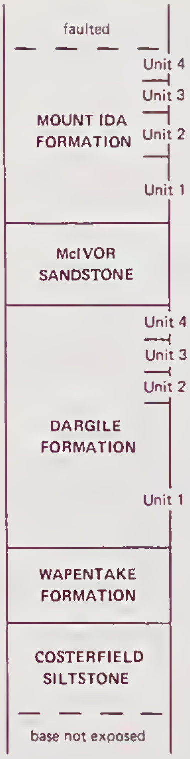


Fig. 1—Silurian-Early Devonian stratigraphic succession in the Heathcote district.

nian. Talent *et al.* (1975) also reported the occurrence of graptolites of the *M. hercynicus* type in the Clonbinane Sandstone Member, which they considered to be a lateral equivalent of the basal part of the McIvor Sandstone. However the identification of Devonian graptolites from this horizon cannot be confirmed and appears to be incorrect as the Ludlovian species *Bohemograptus bohemicus* has been recorded well above the Clonbinane Sandstone Member at Strath Creek (Garratt 1978) and has also been identified by Dr. R. B. Rickards (pers. comm.) from an horizon in the Yea district just below the Rice's Hill Sandstone Member, which Garratt (1978) equated with the Clonbinane Sandstone Member. Assuming that the reported equivalence of all these units is correct, the McIvor Sandstone must be of Ludlovian age and is probably middle to late Ludlovian in view of the occurrence of early Ludlovian graptolites in Unit 2 of the Dargile Formation, much lower in the Heathcote sequence (Jaeger 1966).

The few species of trilobites found in Units 1 and 2 of the Mount Ida Formation are of no value for correlation, but it is of interest to note the presence of encrinurids near the base of Unit 2. The highest occurrence of encrinurids previously recorded in the Heathcote sequence was in Unit 4 of the Dargile Formation (the report by Strusz (1980) of encrinurids occurring in Unit 3 of the Mount Ida Formation was based on incorrect locality information provided by us). Encrinurids were long thought to have died out in the Pridolian and their highest occurrences in certain sequences have been used to suggest the position of the Silurian-Devonian boundary. Recently, however, they have been recorded from strata of Lochkovian age in the Tajna and Mitkov Beds in Podolia (Mozdalevskaya *et al.* 1968, Nikiforova 1977), the Kokbaital horizon in central Kazakhstan (Maksimova 1975), the Kunjak horizon in Tien-Shan (Biske *et al.* 1977), and the West Point Formation in Quebec (Bourque & Lespérance 1977). It is not known whether encrinurids persisted into the Devonian in eastern Australia. Excluding the Mount Ida Formation, the youngest occurrences are in the Florence Quartzite of Tasmania (Gill 1948a), the Derriwong Beds, Trundle Beds and Wallace Shale of New South Wales (Landrum & Sherwin 1976, Talent *et al.* 1975, Strusz 1980), and in limestone lenses outcropping in the Rockhampton district of Queensland (McKellar 1969). The ages of these units lie within the range Pridolian-Lochkovian but are not known with greater certainty.

Several trilobites from Unit 3 of the Mount Ida Formation provide evidence on the age of the fauna. *Ananaspis serrata* (Foerste 1888) was originally described from the Yass Basin of New South Wales, from beds now considered to lie within the upper part of the Elmside Formation, which contains conodonts indicative of the earliest Gedinnian *woschmidti* Zone (Link & Druce 1972). *Scutellum droseron* sp. nov. and *Cheirurus (Crotalocephalina) oxina* sp. nov. are very close morphologically to species occurring in the early Gedinnian Kokbaital horizon of central Kazakhstan. *Proetus (Coniproetus)* sp. nov. resembles *P. (C.) affinis* Boucek 1933 from the Lochkovian of Czechoslovakia. A slightly younger age than that suggested by the preceding species is suggested by *Sthenarocalymene* sp. A (Chatterton, Johnson & Campbell 1979). This species occurs also in the Garra Formation of New South

TABLE 1

STRATIGRAPHIC DISTRIBUTION OF TRILOBITES WITHIN THE MOUNT IDA FORMATION

	Unit 1	Unit 2	Unit 3
Scutellum droseron sp. nov.			X
Proetus (Coniproetus) sp.			X
Tropidocoryphinae gen. et sp. indet.		X	X
Harpidella sp. 1			X
Harpidella sp. 2			X
Cheirurus (Crotalocephalina) oxina sp. nov.			X
Encrinurinae gen. et sp. indet.		X	
Sthenarocalymene sp. A. (Chatterton, Johnson & Campbell 1979)			X
Homalonotinae gen. et sp. indet. 1		X	X
Homalonotinae gen. et sp. indet. 2	X		
Homalonotinae gen. et sp. indet. 3			X
Ananaspis serrata (Foerste 1888)			X
Odontochile cf. *formosa* Gill 1948		X	X
Acastella sp.			X
Acanthopyge (Lobopyge) sp.			X
Leonaspis sp.			X

Wales, which has yielded late Lochkovian-Pragian conodonts (Chatterton, Johnson & Campbell 1979).

In summary, the trilobite fauna of Unit 3 of the Mount Ida Formation tends to support the early Gedinnian age suggested by Philip (1967) on the basis of the brachiopods, although as only a few trilobite species have been found to be useful for correlation the evidence cannot be considered to be sufficient by itself to give such a precise age. If the middle to late Ludlovian age suggested above for the McIvor Sandstone is correct, Units 1 and 2 of the Mount Ida Formation must be at least in part of Pridolian age.

LOCALITIES AND REPOSITORY

The localities referred to in the text are those shown on the locality map given by Talent (1965b, fig. 1) and also on the 1:31,680 geological parish maps published by the Geological Survey of Victoria (Thomas 1940 a, b, 1941). On these maps there is considerable duplication of locality numbers in different parishes and in order to avoid ambiguity the numbers are prefixed here by the initial letter of the parish, as follows: D, Parish of Dargile; H, Parish of Heathcote; R, Parish of Redcastle. Some of these localities do not represent actual outcrops but only loose boulders scattered over the ground; it is unlikely, however, that these boulders were moved an appreciable distance from where they were originally exposed. Locality R25 proved to be much more productive than any of the others and the greater part of the material collected came from here. The described specimens are housed in the palaeontological collections of the National Museum of Victoria (catalogue numbers prefixed NMVP).

SYSTEMATIC PALAEONTOLOGY

Family Scutelluidae R. & E. Richter 1955

Genus **Scutellum** Pusch 1833

Type Species (by original designation): *Scutellum costatum* Pusch 1833 from the Frasnian of Poland (not the Givetian of Germany as stated by Chatterton, Johnson & Campbell 1979; see R. & E. Richter 1926).

Scutellum droseron sp. nov.

Fig. 2P-V

Name: Greek *droseros* meaning dewy, referring to the tuberculate surface sculpture.

Type Material: Holotype, NMV P75100, internal mould of cranidium and counterpart external mould, from locality R25; Fig. 2P,R,U. Paratypes, NMV P75101-4 (cranidia), NMV P75105-6 (librigenae), from locality R25; NMV P75107 (incomplete thorax and pygidium), from 100 m south of locality R31.

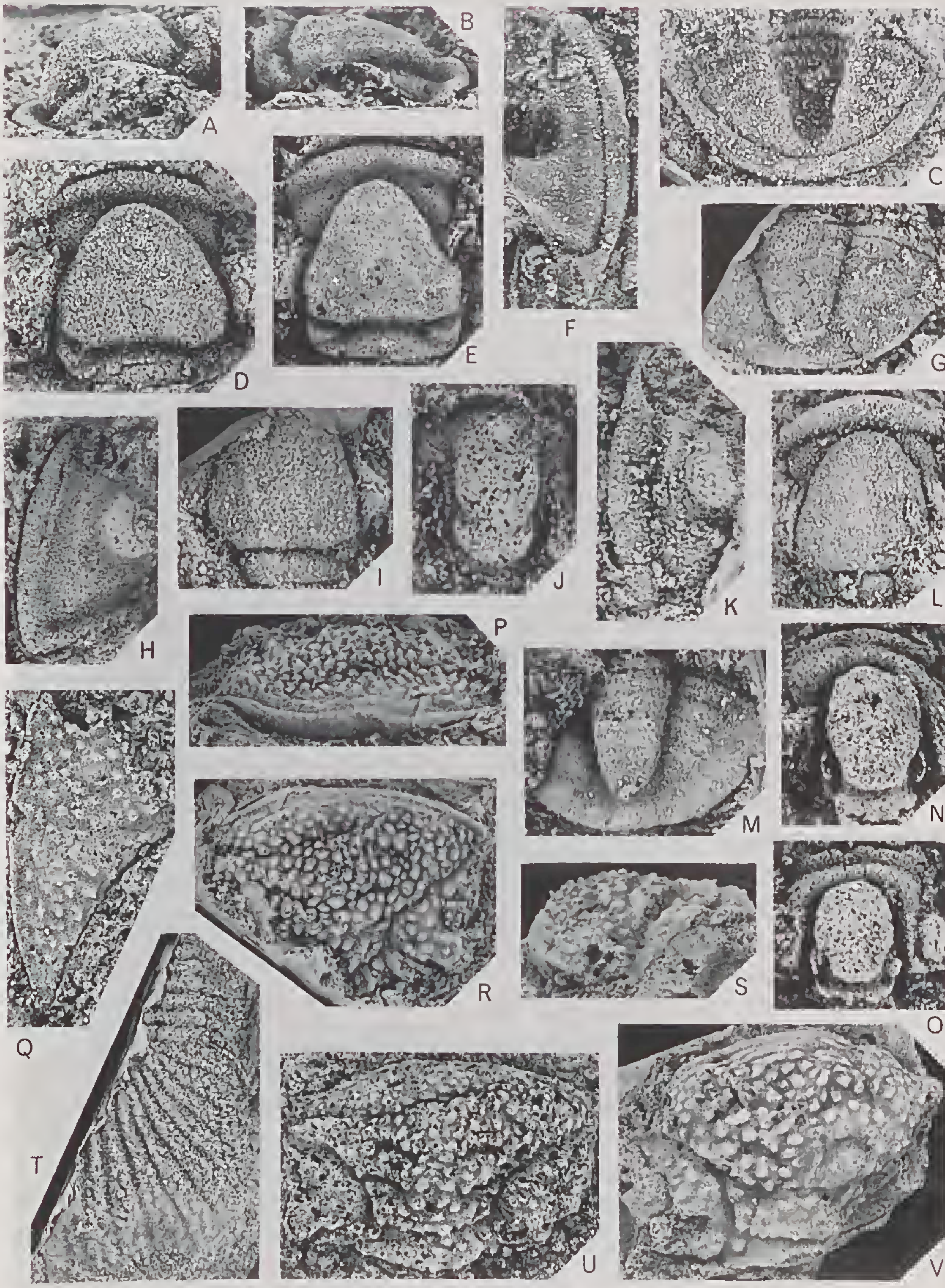
Diagnosis: Dorsal surface of exoskeleton covered with coarse tubercles that are contiguous on glabella and become scale-like on outer part of librigena. Glabella increases in width only slightly between occipital furrow and front of 1p impression but anterior two-thirds is strongly expanded so that width at frontal lobe is 2.5 times that at occipital furrow. Occipital ring short for genus, with large median tubercle or small spine on its posterior margin and large tubercle situated at outer extremity of occipital muscle impression. Glabellar muscle impressions deep but partly obscured by surface tuberculation; anterior limb of 1p deeper than posterior limb; 2p gently convex forwards and slightly oblique; 3p poorly defined, transverse. Outline of palpebral lobe more than a semi-circle; anterior branch of facial suture almost straight, diverging at 25° to sagittal axis, lying just outside axial furrow at frontal glabellar lobe. Genal angle elongate, approximately 35°.

Description: Palpebral width of cranidium almost equal to width at α-α and approximately 1.4 times the length (sag.). Occipital ring convex backwards in dorsal view (with palpebral lobe horizontal), flattened (sag., exsag.) and merging anteriorly with occipital furrow, which is bounded in front by a short, abrupt slope. Occipital muscle impression subrectangular, extending inwards about two-thirds the distance to the sagittal axis. 1p impression parabolic, somewhat expanded (tr.) proximally, enclosing a small inflated lobe; inner end of 2p impression level with glabellar midlength; 3p impression wider and shallower than 2p, lying opposite widest part of frontal lobe. Axial furrow narrow, shallowest adjacent to occipital ring and deepest at lateral muscle impression, diverging at 55°-60° to sagittal axis in front of 1p impression. Preglabellar furrow is gently impressed abaxially and anterior border is short (exsag.) with a rounded crest; furrow and border both fade adaxially and become almost obsolete medially; outer face of anterior border slightly convex (sag., exsag.) and subvertical, decreasing in height abaxially. Anterior border and tubercles on front of glabella bear terrace lines; tubercles immediately behind preglabellar furrow merge into one or more low, transverse ridges.

Palpebral lobe almost equal in height to glabella; steeply inclined portion of fixigena medial to palpebral lobe separated from subhorizontal posterior portion by a furrow directed slightly obliquely forwards from ϵ towards lateral muscle impression; in front of palpebral lobe fixigena slopes anterolaterally. Lateral muscle impression depressed. Lateral border forms a narrow, rather sharp, upturned rim inside which the librigena is flattened or slightly concave, except towards base of eye (not preserved) where is rises slightly. Posterior border furrow on librigena shallow and poorly defined proximally and fading abaxially; posterior border weakly convex, increasing in length (exsag.) abaxially.

Thorax and pygidium poorly preserved, covered with coarse tubercles. Pygidial pleural ribs decreasing in convexity abaxially; median rib (assuming there are seven pleural ribs) not appreciably wider than pleural ribs and non-bifurcate distally.

Remarks: *S. droseron* is closest morphologically to *S. michnevitchi* Maksimova 1968 from the Kokbaital horizon (Early Devonian) of central Kazakhstan. Both species differ from characteristic members of the genus in having a sculpture of coarser tubercles that are con-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tiguous on the glabella; a very strongly expanded anterior part of the glabella; a relatively short (sag., exsag.) occipital ring that lacks a depressed anterior band medial to the occipital muscle impression; deep glabellar impressions; and a tubercle situated at the distal edge of the occipital muscle impression (present in at least some specimens of *S. michnevitchi*; see Maksimova 1968, pl. 4, fig. 4). As compared with *S. michnevitchi, S. droseron* has somewhat smaller tubercles on the glabella; an axial furrow that diverges more gradually in front of the 1p impression; and a less divergent anterior branch of the facial suture.

The only Australian species with which worthwhile comparisons may be made is *S. calvum* Chatterton 1971 from the *Receptaculites* Limestone (late Emsian-early Eifelian) near Yass, New South Wales. *S. calvum* is a characteristic representative of *Scutellum* and so *S. droseron* differs from it in the features listed above. In addition, *S. droseron* has a deeper occipital furrow, a more strongly curved outline of the palpebral lobe, a more divergent anterior branch of the facial suture, a relatively narrower anterior part of the fixigena and shorter (exsag.) abaxial part of the anterior border, and a longer, more acute genal angle. *S. calvum* has gently arcuate, transverse ridges on the front of the glabella as does *S. droseron* but they were described by Chatterton (1971) as terrace lines. The ridges in *S. droseron* are relatively longer (sag., exsag.) and lower than terrace lines, and have terrace lines developed on them.

Family Proetidae Salter 1864

Subfamily Proetinae Salter 1864

Genus **Proetus** Steininger 1831
Subgenus **Proetus (Coniproetus)** Alberti 1966

Type Species (by original designation): *Proetus condensus* Pribyl 1965 from the Koneprusy Limestone (Pragian), Menany, Prague district, Czechoslovakia.

Proetus (Coniproetus) sp. nov.

Fig. 2A-M

Material: At least 20 cranidia, 6 librigenae, 1 hypostome and 40 pygidia from localities R25, R31, approximately 100 m south of R31, and various places between R25 and R30.

Description: Glabella almost as wide as long (sag.), expanding forwards across occipital ring, subparallel-sided between occipital furrow and δ-δ, and thereafter decreasing in width (weakly constricted opposite γ in some specimens) and curving steeply downwards. Occipital ring with median tubercle and prominent lateral lobes; occipital furrow deep, medial portion convex forwards and outer portion deflected anterolaterally. Glabellar furrows 1p and 2p faintly visible abaxially but 3p furrow indistinguishable. Preglabellar field absent, glabella slightly overhanging anterior border furrow. Margin of palpebral lobe strongly flexed at δ but γ-δ and δ-ϵ only weakly curved. Between γ and β anterior branch of suture diverges at about 13° to sagittal axis; posterior branch of suture parallel to axial furrow from ϵ to ζ (the latter lying opposite midlength of occipital lobe) and thereafter turning sharply outwards.

Librigena gently convex inside border furrows, rising beneath eye to become vertical; faint ridge subparallel to outer margin runs midway between lateral border furrow and base of eye, curving backwards and inwards posteriorly. Lateral border flattened; posterior border narrower than lateral border and convex (exsag.); posterior border furrow sharply impressed. Genal angle pointed or extended into short spine. Doublure on librigena convex (tr.) anteriorly, becoming flattened opposite front of eye and narrowing towards posterior extremity; inner edge broadly rounded beneath genal angle, with no sign of panderian notch. Traces of terrace lines preserved towards outside of lateral border and doublure.

Pygidium 1.75 times as wide as long, weakly segmented on axis and pleurae. Axis strongly arched (tr.), 0.3 times as wide anteriorly as maximum width of pygidium, narrowing strongly to bluntly rounded terminus. First ring furrow weaker than articulating furrow and remainder successively fainter, defining 3-5 or possibly 6 axial rings. Pleurae curve gently downwards abaxially and bear 4-5 pleural furrows, of which only the first is sharp; first interpleural furrow faintly distinguishable; broad, weakly convex border defined by slight change of slope.

Remarks: Specimens assigned to this species show varia-

Fig. 2—A-M, *Proetus (Coniproetus)* sp. nov.; A, C, D, H, I, K, L from locality R31; B, E, F, G, M from locality R25; J from 100 m south of locality R31. A, D, cranidium NMV P75109; lateral and dorsal views, ×5. B, E, cranidium NMV P75108; lateral and dorsal views, ×4. C, latex cast of pygidial mould NMV P75117; ventral view, ×3.5. F, latex cast of librigenal mould NMV P75113; ventral view, ×3.5. G, latex cast of external mould of pygidium NMV P75115; dorsal view, ×3.5. H, librigena NMV P78290; dorsal view, ×3.5. I, latex cast of incomplete external mould of cranidium NMV P75111; dorsal view, ×4.5. J, hypostome NMV P75112; ventral view, ×5.5. K, latex cast of external mould of librigena NMV P75114; dorsal view, ×4. L, latex cast of external mould of cranidium NMV P75110; dorsal view, ×3.5. M, latex cast of external mould of pygidium NMV P75116; dorsal view, ×3.5. N, O, *Harpidella* sp. 1, from locality R25. N, cranidium NMV P78291; dorsal view, ×6.5. O, cranidium NMV P48746; dorsal view, ×8. P-V, *Scutellum droseron* sp. nov.; T from 100 m south of locality R31, remainder from locality R25. P, R, U, holotype cranidium NMV P75100; ×2; P, R, latex cast of external mould in anterior and dorsal views; U, counterpart internal mould in dorsal view. Q, librigena NMV P75105; dorsal view, ×2. S, V, cranidium NMV P75101; lateral and dorsal views, ×1.5. T, incomplete thorax and pygidium NMV P75107; dorsal view, ×0.9. Except where otherwise stated, specimens are internal moulds.

tion in the convexity (sag.) of the glabella, the weak constriction of the glabella opposite γ in some individuals, the degree of taper of the pygidial axis, and possibly the length of the genal spine (compare Fig. 2A, D with 2B, E). Some of the observed differences may be due to tectonic distortion.

P. (C.) affinis Boucek 1933 from the Lochkovian of Czechoslovakia is similar to this species but in the former the eye is situated further from the lateral border, the hypostome is wider, the pygidial axis is more strongly segmented, and the pygidial border is better defined. Only a cranidium of the type species, *P. (C.) condensus*, has been illustrated (Pribyl 1965, pl. 1, fig. 1), but Owens (1973, text-fig. 3C, D) figured a cephalon and a pygidium of *P. (C.) glandiferus* Novák 1890, which he considered to be a synonym of *P. (C.) condensus*. These specimens differ from the present species in that the occipital ring is wider (tr.) than the basal part of the glabella; the palpebral lobes are situated slightly further forward; the pygidium is more strongly segmented and more transverse; there is a greater number (7-8) of axial rings and they are more convex (sag., exsag.) and have muscle scars impressed abaxially; and the pygidial border is better defined.

The only previously described species of the subgenus from Australia is *P. (C.) irroratus* Chatterton, Johnson & Campbell 1979 from the Garra Formation (Early Devonian) of central New South Wales. It is not very close to the present species, which has a relatively shorter glabella, more posteriorly placed palpebral lobes, more weakly divergent section γ-β of the facial suture, no eye socle, and a more weakly segmented pygidium. There are similarities with the fragmentary cranidium figured by Chatterton, Johnson & Campbell (1979, pl. 104, fig. 23) as *P. (Coniproetus)?* sp., but cranidia from the Mount Ida Formation have a more conical glabella, and no preglabellar field.

The present species appears to occur also in the Humevale Formation near Lilydale, Victoria. Formal naming of the species will be deferred until work in progress on the Lilydale faunas is complete.

Subfamily Tropidocoryphinae Pribyl, 1946

Tropidocoryphinae gen. et sp. indet.

Fig. 4S-V

1965b Proetidae indet. gen. and sp. B. Talent, p. 48, pl. 25, figs. 4, 5.

Material: A cephalon NMV P59652, and pygidium NMV P59653 (formerly 46739 and 46740 respectively in the Geological Survey of Victoria collections), from locality R26; also a cranidium and 4 pygidia from approximately 300 m east of locality R25.

Remarks: The cephalon and pygidium from locality R26 were figured by Talent (1965b). The cephalon is a badly crushed internal mould with parts of the exoskeleton adhering. The glabella is gently convex, subparabolic in outline, and lacks lateral furrows. The occipital furrow is firmly impressed, transverse or slightly convex forwards medially and deflected forwards distally. The axial furrow is shallow but distinct and merges with the anterior border furrow in front of the glabella. The anterior and lateral borders are flattened and bear fine terrace lines around their outer margins; the border furrows are broad, shallow and poorly defined. Talent (1965b) could find no trace of eyes and concluded that this species was blind but it seems more likely that the eyes were obliterated during crushing of the specimen because the palpebral lobe, outlined by the facial suture, is visible on the left cheek. The pygidium is wider than long, with a relatively narrow, strongly arched axis and weakly convex pleurae having a slightly raised rim around the outside. The axial rings and pleural ribs are flattened (sag., exsag.). The pleural furrows are very shallow and the interpleural furrows even fainter. There are traces of very fine terrace lines on the pleurae, expecially around the margins.

This species appears to be closely related to *'Proteus' bowningensis* Mitchell 1887 from the upper Ludlovian to lower Gedinnian of the Yass Basin, New South Wales. *'P.' bowningensis* was assigned by Owens (1973) to *Latiproetus* Lu 1962 but Holloway (1980) considered that until the type species was better known, that genus should not be used. Talent (1965b) considered the present material to bear some resemblance to *Lepidoproetus* Erben 1951 but members of that genus differ in the structure of the anterior and lateral cephalic borders (see Alberti 1969, Holloway 1980) and in addition have a glabella that is subquadrate instead of narrowing anteriorly, a more transverse pygidium with a broader, more conical axis, and pygidial axial rings that stand higher at the posterior edge than the ring behind.

The specimens from 300 m east of locality R25 are much smaller and more poorly preserved than those from R26 but appear to belong to the same species.

Family Aulacopleuridae Angelin 1854

Subfamily Aulacopleurinae Angelin 1854

Genus **Harpidella** McCoy 1849

Type Species (by monotypy): *Harpes? megalops* McCoy 1846 from the upper Llandoverian at Boocaun, Cong, County Galway, Ireland.

Harpidella sp. 1

Fig. 2N, O

Material: Five cranidia from locality R25.

Remarks: These cranidia are assigned to *Harpidella* because of the very large, posteriorly placed palpebral lobe; the presence of an eye ridge; and the distinct glabellar furrow 2p (opposite the front of the palpebral lobe in Fig. 2O). In having an elongated glabella that does not narrow strongly in front of the 1p lobe, very small 1p lobes, and weakly curved 1p furrows, they resemble most closely the species *H. distincta*, *H. tantula* and *H. kobayashii* described by Pribyl & Vanek (1981) from the Pragian to Zlichovian of Czechoslovakia.

A species of *Harpidella* from the underlying McIvor

Sandstone was described and figured by Talent (1965b, pl. 24, figs. 7, 8) as Proetidae indet. gen. and sp. A. It is not very similar to the present material, having a relatively shorter, anteriorly narrowing glabella and larger 1p lobes.

Harpidella sp. 2

1965b *Otarion?* n. sp. Talent, p. 48, pl. 25, fig. 6.

MATERIAL: A cranidium NMV P59654 (formerly 37979 in the Geological Survey of Victoria collections), from locality R9.

REMARKS: This cranidium which was figured by Talent (1965b) is very similar to *Harpidella* sp. 1 but the 1p lobes are slightly larger and more triangular in shape, the preglabellar field is longer and more convex (sag.), and the anterior border is not evenly curved in dorsal view but is strongly flexed medially.

Family CHEIRURIDAE Salter 1864
Subfamily CHEIRURINAE Salter 1864

REMARKS: The presence of continuous glabellar furrows 2p and 3p is a feature of most Devonian cheirurinids. All such species were formerly assigned to *Crotalocephalus* Salter 1853, which was generally considered to be a subgenus of *Cheirurus* Beyrich 1845, but in recent years some of them have been included in four new taxa: *Crotalocephalina* Pribyl & Vanek 1964; *Crotalocephalides* Alberti 1967; *Pilletopeltis* Pribyl *in* Pillet 1973; and *Geracephalina* Kobayashi & Hamada 1977. This has led to confusion about the identity of *Crotalocephalus* itself because there seems to be no valid designation of a type species, a problem that has been discussed by Lane (1971). For present purposes it will be assumed, in accordance with traditional usage, that *Crotalocephalus* includes species such as *Cheirurus (Crotalocephalus) sternbergii* (Boeck 1827) and *C. (C.) pengellii* (Whidborne 1889). Thus *Pilletopeltis* Pribyl *in* Pillet 1973 (*nomen novum* for *Boeckia* Pillet 1965 *non* Malm 1870, and a senior synonym of *Pilletopeltis* Pribyl & Vanek 1973), which has *C. (C.) sternbergii* as type species, is here considered to be a synonym of *Crotalocephalus*. *Geracephalina* is also considered to be a synonym of *Crotalocephalus* because the feature on which it is based—the presence of a sagittal furrow on the 3p and occasionally the 2p lobe—seems to be of no more than specific importance, and in at least some cases is teratological (Prantl 1947).

Genus **Cheirurus** Beyrich 1845
Subgenus **Cheirurus (Crotalocephalina)** Pribyl & Vanek 1964

TYPE SPECIES (by original designation): *Cheirurus gibbus* Beyrich 1845 from the Dvorce-Prokop Limestone (Pragian), Podolí (Dvorce), Prague, Czechoslovakia.

DIAGNOSIS: Subgenus of *Cheirurus* having continuous glabellar furrows 2p and 3p, and a pygidium with short, broad marginal spines.

REMARKS: In addition to the shape of the marginal spines on the pygidium Pribyl & Vanek (1964, 1973) considered *C. (Crotalocephalina)* to be characterised especially by a "transversely arched and longitudinally elliptical, somewhat laterally compressed exoskeleton" (our translation). This is certainly true of species such as *C. (Crotalocephalina) gibbus* and *C. (Crotalocephalina) globifrons* Hawle & Corda 1847, in which the pleural regions on the cephalon, thorax and pygidium are markedly reduced in width (tr.) relative to the axis. Thus in *C. (Crotalocephalina) gibbus* the cheeks and the thoracic pleurae are only about one half the width (tr.) of the occipital ring and the thoracic axial rings respectively, whereas in *C. (Crotalocephalus) sternbergii* and related species they are almost equal in width to the axis, or even wider than it. There are, however, a number of species that resemble *C. (Crotalocephalina) gibbus* in the shape of the pygidial spines and yet their pleural regions are no more reduced in width than those of *C. (Crotalocephalus) sternbergii*. These species, which include *C. (Crotalocephalina) chlupaci* Pribyl & Vanek 1962, *C. (C.) expansus* Balashova 1965, *C. (C.) hexaspinus* (Maksimova 1960), and *C. (C.) oxina* sp. nov., also appear to us to show no significant difference from *C. (Crotalocephalus) sternbergii* in the degree of transverse arching of the exoskeleton.

In our opinion, most of the other characters listed by Pribyl & Vanek in their diagnosis of *C. (Crotalocephalina)* cannot be used to distinguish this taxon from *C. (Crotalocephalus)* either. The rate of expansion of the glabella is variable in both subgenera but the amount of variation is only slight. Glabellae with inflated frontal lobes and 2p and 3p furrows that are almost straight are found also in some species of *C. (Crotalocephalus)*, such as *C. (C.) pengellii* (see Lütke 1965, pl. 20, figs. 13, 14) and *C. (C.) copiosus* Haas 1968, but these features are not present in *C. (Crotalocephalina) oxina* sp. nov. The genal spines in *C. (Crotalocephalina) hexaspinus* (Maksimova 1960) are no shorter than those in most species of *C. (Crotalocephalus)*. From published illustrations we are unable to confirm the lack of a preannulus on the thoracic segments of *C. (Crotalocephalina) gibbus* or *C. (C.) globifrons*, but one is present on the thoracic segment of *C. (C.) oxina* described below. At any rate, a preannulus is present in some species of *C. (Cheirurus)* but is poorly developed or absent in others. Finally, although we can find no published photographs of *C. (Crotalocephalus)* showing the ventral surface of the pygidium, the reconstruction given by Pribyl & Vanek (1973, text-fig. 3) shows no apparent differences from *C. (Crotalocephalina)* in the width of the pygidial doublure.

There is even some difficulty in separating *C. (Crotalocephalus)* and *C. (Crotalocephalina)* on the basis of the length and thickness of the pygidial spines because there is almost continuous variation between the extremes. In this respect, species such as *C. (Crotalocephalus) pauper* Barrande 1852, *C. (Crotalocephalus) maurus* Alberti 1966, and *C. (Crotalocephalus) africanus* Alberti 1967 lie almost midway between *C. (Crotalocephalus) sternbergii* and *C. (Crotalocephalina)* *gibbus* and in fact bear a closer resemblance to species of *C. (Cheirurus)*. It seems, therefore, that *C. (Crotalocephalus)* and *C. (Crotalocephalina)* intergrade morphologically and we consider it inappropriate to recognise them as independent genera, as advocated by Lane (1971). He proposed that they belong to separate evolutionary lineages but we can see no evidence to support this.

Cheirurus (Crotalocephalina) oxina sp. nov.

Fig. 3M-U

Name: Greek *oxina* meaning a harrow or rake, referring to the appearance of the pygidium.

Type Material: Holotype, NMV P75137, internal mould of pygidium and counterpart external mould, Fig. 3P, R, S; paratypes, NMV P75138-9, P75143, P75149 (cranidia), NMV P75140 (hypostome), NMV P75141-2 (thoracic segments), NMV P75144, P75147-8 (pygidia); all from locality R25.

Diagnosis: Glabella subparallel-sided; furrows 2p and 3p almost as oblique as 1p, so that 2p lobe is only slightly longer sagittally than distally. Fixigena broad, palpebral lobe lying distant from lateral border furrow; genal spine very short and strongly divergent. Thoracic pleurae slightly wider (tr.) than axial rings. Marginal spines on pygidium subtriangular, flattened in cross-section; first and second spines deflected backwards half way along their length so that tips of first pair are level with posterior end of axis; third pair much shorter than others and directed straight backwards. Posteromedian projection absent, notch between third pair of spines narrowing to an acute angle.

Description: Occipital ring twice as long sagittally as distally and gently convex (sag.); outermost two-fifths of occipital furrow occupied by slit-like apodemal pit, medial portion of furrow clearly distinguishable at posterior of depressed area between 1p lobes (Fig. 3O). 1p furrow directed obliquely backwards from axial furrow at approximately 65° to sagittal line, 1p apodeme 1.5 times as wide as occipital apodeme. 2p and 3p furrows shallow slightly adaxially, outer end of 2p opposite glabellar midlength (sag.). Frontal glabella lobe 0.4 times length (sag.) of glabella. Posterior border strongly rounded (exsag.) adaxially but decreasing in convexity beyond fulcrum; lateral border with slightly angular outward projection in line with posterior border furrow, and a similar but smaller projection immediately behind ω. Palpebral lobe situated with anterior edge opposite front of 3p lobe and posterior edge opposite outer end of 2p furrow. Anterior branch of facial suture falls steeply in front of γ, becomes horizontal opposite anterior pit in axial furrow, and curves inwards opposite widest part of frontal lobe; posterior branch of suture runs parallel to posterior border to meet lateral margin of cheek at 90°. Regularly spaced tubercles present on glabella, excluding occipital ring; inner part of fixigena coarsely pitted.

Middle body of hypostome divided into subcircular anterior lobe and subcrescentic posterior lobe by middle furrow that is well defined laterally but obsolete medially. Lateral margins of hypostome converge behind shoulder at 50°; posterior margin transverse.

Axial ring of thoracic segment strongly arched (tr.), approximately equal in length sagittally and distally but contracting to two-thirds this length half way between. Medial portion of ring divided by weak transverse change of slope into small, flattened (sag.), lenticular anterior band and convex posterior band bearing a pair of large tubercles. Pleura of usual form for subfamily, articulated portion comprising half the width; pleural band increases in height near fulcrum where it merges with a flattened, lanceolate spine that is sharply downturned at approximately 45° to the horizontal and curves backwards slightly distally.

Ratio of pygidial widths across tips of marginal spines approximately 1.5:1.0:0.3. First axial ring more prominent than remainder, inclined slightly forwards, and contracted medially; second and third rings (excluding well developed pseudo-articulating half ring on second) of constant length (sag., exsag.); posterior terminus a small subcircular swelling. Axial furrow distinct at first axial ring, poorly defined adjacent to rings 2 and 3 and axial terminus, except at the distal ends of each of the ring furrows where it contains a deep pit; on internal moulds axial furrow deeper than on external surface. First pleural furrow deep, curving outwards abaxially; first interpleural furrow sharply impressed proximally but fading towards the margin and gently curving backwards. Second pleural furrow also deep, narrower

Fig. 3—A-L, *Sthenarocalymene* sp. A (Chatterton, Johnson & Campbell 1979); D from locality R54, remainder from locality R25. A, B, E, cranidium NMV P47977; lateral, dorsal and oblique views, ×2.5. C, latex cast of external mould of cranidium NMV P75130; lateral view, ×2. D, librigena NMV P75136; dorsal view, ×2.75. F, latex cast of external mould of cranidium NMV P75133; dorsolateral view, ×2. G, latex cast of external mould of cranidium NMV P75131; dorsal view, ×2.5. H, J, pydigium NMV P47980; lateral and dorsal views, ×2. I, latex cast of external mould of pygidium NMV P47961; dorsal view, ×2. K, latex cast of external mould of pygidium NMV P75134; dorsal view, ×2. L, latex cast of pygidial mould NMV P75135; ventral view, ×2.5. M-U, *Cheirurus (Crotalocephalina) oxina* sp. nov., from locality R25. M, incomplete cranidium NMV P75138; dorsal view, ×1.5. N, thoracic segment NMV P75141; dorsolateral view, ×2.75. O, latex cast of external mould of cranidium NMV P75139; dorsal view, ×1.5. P, R, S, holotype pygidium NMV P75137, ×2.5: P, R, latex cast of external mould in dorsal and lateral views; S, latex cast of counterpart in ventral view. Q, hypostome NMV P75140; ventral view, ×3.75. T, cranidium NMV P75143; dorsal view, ×1.25. U, incomplete pygidium NMV P75144; dorsal view, ×1.75. V, W, Encrinurinae gen. et sp. indet., from locality R52. V, pygidium NMV P75146; dorsal view, ×3.5. W, librigena NMV P75145; oblique view, ×3. Except where stated otherwise, specimens are internal moulds.


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(tr.) than first and directed more strongly backwards; anterior pleural band on second segment much lower than posterior band; second interpleural furrow faint. Third pleural furrow absent on smaller pygidium but deep on larger one, which is an internal mould (Fig. 3P, U). Pygidial doublure deeply notched posteromedially and narrowing gradually towards anterolateral extremities; it slopes gently inwards over most of its extent, but around posteromedian notch is flexed sharply upwards to stand almost vertically. Ventral surface of marginal spines separated from doublure by short, abrupt slope.

REMARKS: In the width of the fixigenae, the very short and subtriangular pygidial spines, and the lack of a posteromedian projection on the pygidium, *C. (C.) oxina* resembles *C. (Crotalocephalina) expansus* Balashova 1965 from the Early Devonian Kokbaital horizon of Kazakhstan (see Maksimova 1968, pl. 33, figs. 1-4). *C. (C.) expansus* differs from *C. (C.) oxina* in that the glabella expands more strongly forwards; there is a weak sagittal furrow on the 3p lobe; the frontal glabellar lobe is relatively larger and more inflated; the first pygidial axial ring does not appear to be contracted medially and a pseudo-articulating half ring is not developed on the second axial ring; the axial terminus is better defined and more transverse; the anteriormost pygidial spines are not directed as strongly backwards; and the notch between the third pair of spines is broader and more rounded in outline. *C. (Crotalocephalina) hexaspinus* (Maksimova 1960) also has a pygidium with very short marginal spines and no posteromedian projection, but the spines differ in shape from those of *C. (C.) oxina*, and the cranidium bears little resemblance to that of the Australian species (see Maksimova 1968, pl. 34).

Two cheirurinid species have previously been named from the Early Devonian of southeastern Australia and each is known only from a single incomplete cranidium, so that there is some doubt about their subgeneric assignment. *C. (Crotalocephalus) regius* Foldvary 1970 from the Trundle district of New South Wales differs from *C. (C.) oxina* in having a relatively longer frontal glabellar lobe, more oblique 3p furrow, relatively narrower cheeks, and more prominent tuberculation. *C. (Crotalocephalus) packhami* Strusz 1964 from the Garra Beds near Wellington, New South Wales, has a frontal glabellar lobe that is more subquadrate in dorsal view and a 2p lobe that is significantly longer sagittally than distally.

Etheridge & Mitchell (1917) described two Silurian cheirurinid species from the Yass Basin of southern New South Wales as *Crotalocephalus silverdalensis* and *C. sculptus*. Both of these are from beds now assigned to the Yarwood Siltstone Member of the Black Bog Shale, which is of late Ludlovian age (Link 1970). *C. sculptus* was said to differ from *C. silverdalensis* in having a proportionally longer and narrower glabella, a larger frontal lobe, furrows 2p and 3p that are more acutely flexed medially, and thoracic segments with a more convex (tr.) axis and relatively longer pleural spines. On examining casts of the type specimens of both species, we can see no significant differences in the proportions of the glabella or the length of the pleural spines, and we attribute the other differences to tectonic distortion. *C. silverdalensis* and *C. sculptus* are alike in all other observable characters and we consider them to be synonymous. They are not very similar to *C. (C.) oxina*, and in fact their generic or subgeneric assignment is uncertain. In the length and thickness of the pygidial spines they are closer to *C. (Crotalocephalina)* than to *C. (Crotalocephalus)*, but they differ from species normally assigned to either of these taxa in the form of the occipital and 1p furrows. These furrows do not merge medially but are separated by a very short (sag.), slightly depressed portion of the 1p lobe bearing subdued tubercles. The occipital and 1p furrows do merge medially, however, in the specimens from the Boola Beds (Early Devonian) of eastern Victoria that Philip (1962) referred to as *C. (Crotalocephalus) silverdalensis*. These specimens also differ from the Yass species in the shape of the glabella, the inflation of the frontal glabellar lobe, the form of the 2p and 3p furrows, the thickness and disposition of the pygidial spines, and the lack of a posteromedian projection on the pygidium.

Family ENCRINURIDAE Angelin, 1854
Subfamily ENCRINURINAE Angelin, 1854

Encrinurinae gen. et sp. indet.

Fig. 3V, W

MATERIAL: A librigena and 7 pygidia from locality R52.

DESCRIPTION: Lateral border on librigena relatively narrow, covered with closely spaced tubercles; lateral border furrow deep and U-shaped in cross section. Shallow vincular furrow present on lower edge of border posteriorly but dying out before reaching pseudoglabellar region.

Pygidium approximately 1.3 times as wide as long, lateral margins converging at about 100° towards rounded posterior extremity. Axis strongly arched (tr.) anteriorly but decreasing in height posteriorly and merging with postaxial region; 10-15 axial rings are distinguishable but there is no evidence of median tubercles on any of them. Pleurae curve steeply downwards abaxially, composed of 7?-10 pleural ribs which near back of pygidium are deflected slightly inwards abaxially, posterior pair tending to fuse distally behind axis. On external moulds pleural ribs are flat-topped and pleural furrows are short (exsag.) and sharply incised.

REMARKS: In the number of axial rings and pleural ribs and the apparent lack of median tubercles on the axis, these pygidia resemble the species from the Dargile Formation (Ludlovian) described by Talent (1965b) as *Encrinurus simpliciculus*, which we consider to be a junior synonym of *Cromus spryi* (Chapman 1912). The type locality of *C. spryi* is in the South Yarra area of Melbourne and was said by Strusz (1980) to lie within the Anderson Creek Formation of Wenlockian age, but the strata in this area were assigned to the Dargile Formation by VandenBerg (1974). Strusz (1980) noted that *E. simpliciculus* resembles species of *Cromus* in the glabellar tuberculation but stated that it differs from them in the more posterior position of the eye, the preglabellar furrow that is incomplete medially, the lack of a median longitudinal furrow on the cranidial portion of the pseudoglabellar region, and the form of the pygidium. We can see no significant difference between. *E. simpliciculus* and *C. spryi* in any of these features. Although the specimens of *C. spryi* figured by Strusz (1980, pl. 1, figs. 1-3) appear to have wider pygidial pleurae than the types of *E. simpliciculus*, we attribute this to tectonic flattening.

Family Calymenidae Milne Edwards 1840
Subfamily Flexicalymeninae Siveter 1976

Genus Sthenarocalymene Siveter 1976

Type Species (by original designation): *Sthenarocalymene lirella* Siveter 1976 from the *Ampyx* Limestone (Llandeilo to lowermost Caradoc), Oslo-Asker district, Norway.

Remarks: This genus has recently been discussed by Holloway (1980) who gave reasons for considering it to be a senior synonym of *Apocalymene* Chatterton & Campbell 1980.

Sthenarocalymene sp. A

Fig. 3A-L

1965b *Gravicalymene* cf. *angustior* (Chapman); Talent, p. 49, pl. 26, figs. 3, 4, ?5.

1979 *Apocalymene* sp. A. Chatterton, Johnson & Campbell, p. 813, pl. 104, figs. 28, 29; pl. 106, figs 10, 16-27.

Material: At least 15 cranidia, 4 librigenae and 20 pygidia from localities R25 and R54.

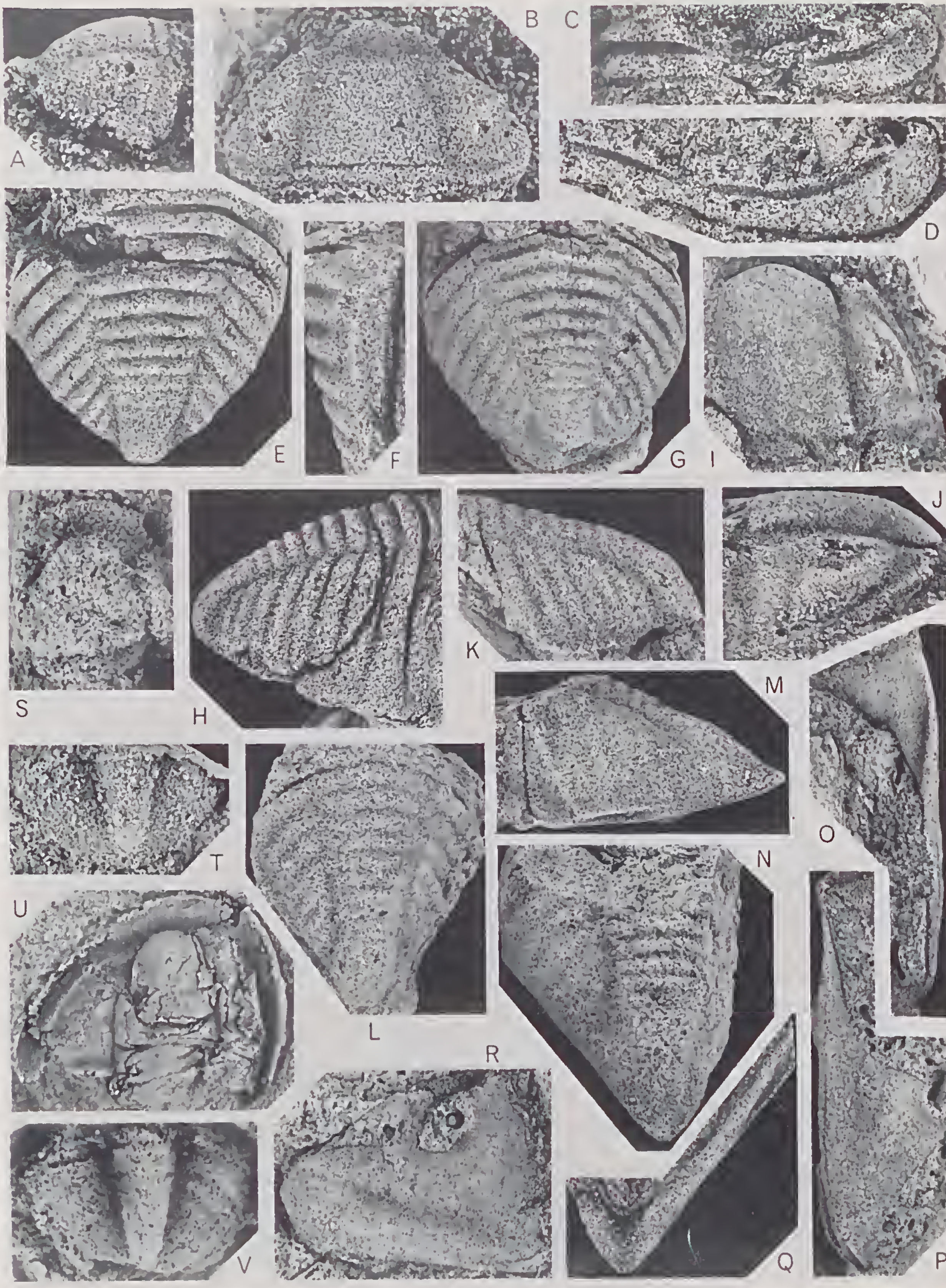
Remarks: Our material differs only in a few details from the description and photographs given by Chatterton, Johnson & Campbell (1979). They stated that the palpebral lobes are situated so that δ-δ passes through the 2p furrow, but in our material they are slightly further back. In addition, the fifth pygidial axial ring is possibly not as well defined in the Mount Ida specimens, the axis is more distinctly separated from the postaxial ridge, and the exoskeletal granules tend to increase in size and become stronger towards the margin of the pygidium. Some of these differences may be due to the larger size of the Mount Ida specimens.

The approximately contemporaneous species *S. angustior* (Chapman 1915) from the Humevale Formation at Lilydale, Victoria has not been well illustrated, but examination of type and topotype specimens in the National Museum of Victoria shows that they differ from *Sthenarocalymene* sp. A in having a glabella that narrows forwards more strongly and is more rounded anteriorly; a palpebral lobe that is situated slightly further forward (with δ opposite the 2p furrow); a higher anterior border; a narrower pygidial axis that is indistinctly separated from the postaxial ridge; no cincture on the pygidium; and pleural and interpleural furrows that are deeper abaxially. *S. hetera* (Gill 1945) and *S. kilmorensis* (Gill 1945), which were stated to be of Gedinnian-Siegenian age by Chatterton, Johnson & Campbell (1979), are in fact from the Dargile Formation (Ludlovian) at Kilmore East, Victoria. They are probably synonymous, the differences in the shape of the glabellae evident in the figures given by Gill (1945, pl. 7, figs. 9, 12) being due almost certainly to tectonic distortion. These species differ from *Sthenarocalymene* sp. A in having much higher anterior borders, glabellae that narrow more strongly anteriorly and do not project as far forward with respect to the central part of the cheek, and relatively longer 1p lobes.

Family Homalonotidae Chapman 1890
Subfamily Homalonotinae Chapman 1890

Remarks: The classification of Silurian and Devonian homalonotinids is in a confused state because the majority of described species are in need of revision or are known only from fragmentary material. Tomczykowa (1975) recently reviewed all of the established genera and subgenera (elevating the latter to generic rank) and reassigned some of the species, but did not undertake a revision of any of the type species. She suggested that less weight in classification should be given to the form of the rostral plate, as the presence or absence of a rostral process was in her view largely of adaptive significance. In diagnosing the genera she therefore employed only features of the dorsal exoskeleton, some of which appear to us to be of doubtful taxonomic value at this level. There are no distinctive differences between any of the genera in the shape of the glabella and the strength of the thoracic segmentation, and the degree of glabellar lobation is variable even within individual species (see Clarke 1913, pl. 2). Of the other features listed by Tomczykowa in her Table 5, the shape of the pygidium and its degree of trilobation and segmentation are extremely variable within the generic groupings she has made. It is difficult to believe that there are significant differences in any of these features between her species *Trimerus novus* and the specimens she has illustrated as *Digonus vialai* (Gosselet) and *Parahomalonotus forbesi* (Rouault) (see Tomczykowa 1975, pl. 3, figs 5-7, pl. 4, figs 10, 11, pl. 6, figs 1, 3), or between her species *Trimerus lobatus* and *Dipleura praecox* (Tomczykowa 1975, pl. 2, figs 7, 11). Furthermore the species *Homalonotus clarkei* Kozlowski which has a pygidium with an acutely pointed posterior termination is assigned by her to *Dipleura*, the type species of which has a pygidium that is broadly rounded posteriorly.

The ventral morphology of the exoskeleton is known in only a few homalonotinid species at present but we believe that consideration of the structures on the cephalic and pygidial doublures may help in the elucidation of relationships within the subfamily. For example, it is apparent that some species possess different styles of vincular furrows on their pygidial doublures (compare Salter 1865, pl. 12, fig. 9a with Fig. 4Q herein), whereas others have none at all (Wolfart 1968, pl. 3, figs 1b, 2d)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and our investigations have shown that a vincular furrow is present on the cephalic doublure in some species. These differences presumably reflect differences in enrollment patterns. We also believe that insufficient evidence exists at present to dismiss the form of the rostral plate as a taxonomically useful character.

Homalonotinae gen. et sp. indet. 1

Fig. 4A-H

1965b *Trimerus (Dipleura?)* sp. Talent, p. 49-50 (in part), pl. 26, figs 1, 2 (not text-fig 6).

MATERIAL: A cephalon, a cranidium, 3 thoracic segments and 7 pygidia from localities D2, D3 and D4.

DESCRIPTION: Cephalon subtriangular, posterior margin deflected forwards distally to well-rounded genal angle, anterior outline weakly curved laterally and interrupted medially by forwardly projecting anterior border (edge of border broken off on specimen). Glabella wider posteriorly than long, narrowing uniformly forwards; anterior outline transverse; no trace of glabellar furrows. Axial and preglabellar furrows broad, shallow and poorly defined; occipital furrow more sharply impressed than posterior border furrow. Cheek gently convex (exsag., tr.), sloping anteriorly and laterally from distal end of occipital ring. Palpebral lobe situated opposite glabellar midlength; anterior branch of facial suture converges parallel to axial furrow as far as front of glabella, thereafter becoming indistinct; posterior branch directed laterally from ϵ but not distinguishable distally.

Pleurae of thoracic segments have large articulating facets and broadly rounded tips. Medial to fulcrum, pleural furrow deep with steep anterior slope and more gently inclined posterior slope; beyond fulcrum it shallows and gradually curves forwards in a broad arc.

Pygidium approximately as wide as long, posterolateral margins gently convex. In transverse profile pleurae slope steeply downwards from axial furrow in a gentle curve; axis lacks independent convexity anteriorly but becomes slightly inflated posteriorly. In lateral profile crest of axis inclined at 50° to plane of lateral margin. Axis composed of strongly tapering segmented portion of 10 axial rings and a subparallel-sided terminus extending to posterior extremity of pygidium; ring furrows distinctly flexed medially in dorsal view. Anterior width of axis almost two-thirds maximum pygidial width. Axial furrow weaker than ring furrows anteriorly but increasing in depth slightly posteriorly. Pleura on anteriormost segment divided into short (exsag.) anterior band and gently convex (exsag.) posterior band by deep, sharp pleural furrow that is continuous with articulating furrow proximally and runs onto articulating facet distally; anterior band expands abaxially as far as inner edge of facet, posterior band expands slightly beyond fulcrum. Remainder of pleurae composed of 7 ribs defined by shallow rib furrows that fade towards lateral margin; between posteriormost rib and terminal piece of axis is a gently concave, subtriangular region formed in part of axial furrow and eighth rib furrow. Doublure narrow and semitubular; flattened and steeply inclined portion of border roll immediately behind articulating facet bounded below by slight vincular furrow (Fig. 4F).

REMARKS: This material is very close to the species from the Humevale Formation described by Gill (1949) as *Trimerus lilydalensis*, and may actually belong to it. The collections of the National Museum of Victoria contain several topotype and other specimens of *T. lilydalensis* that are better preserved than the types, but in the present state of knowledge of Silurian and Devonian homalonotinids they cannot be assigned with certainty to any established genus. The closest similarity seems to be with certain species presently referred to *Burmeisteria (Digonus)*, such as *B. (D.) noticus* (Clarke 1913) and *B. (D.) accraensis* Saul 1967. *T. lilydalensis* differs from these species, however, in that the rostral suture does not run along the margin of the anterior border, so that the rostral plate has a small, subtriangular dorsal portion; the rostral plate lacks a medial process; and there is a well-developed vincular furrow on the cephalic doublure, directed anteromedially from the outer end of the hypostomal suture. There are also similarities with *Trimerus (Dipleura)*, especially in the form of the rostral plate and in the fact that the anterior branch of the facial suture joins in a smooth curve in front of the glabella (Wolfart 1968, pls 1-3; note that the appearance of a transverse rostral suture in some of the illustrations by Hall & Clarke 1888, pls 2-5, is due to breakage of the specimens, and the diagnosis and reconstruction given

Fig. 4—A-H, Homalonotinae gen. et sp. indet. 1; A, B, from locality D4; C, D from locality D2; E-H from locality D3. A, B, cephalon NMV P78292; lateral and dorsal views, ×1.5. C, fragmentary thoracic segment NMV P78293; dorsolateral view (anterior at top of photograph), ×2. D, fragmentary thoracic segment NMV P78294; dorsolateral view (anterior at top of photograph), ×2. E, H, pygidium NMV P78295; dorsal and lateral views, ×1.75. F, G, pygidium NMV P59656, figured by Talent (1965b, pl. 26, fig. 2); F, anterior part of border roll in right ventrolateral view, showing slight vincular furrow, ×2.5; G, dorsal view, ×1.5. I-L, Homalonotinae gen. et sp. indet. 2, from locality H25. I, J, incomplete cephalon NMV P78296; dorsal and lateral views, ×1.5. K, L, pygidium NMV P78297; lateral and dorsal views, ×2. M-R, Homalonotinae gen. et sp. indet. 3; O, P, from locality R25, remainder from locality R55. M, N, Q, pygidium NMV P78298; lateral, dorsal and ventral views, ×1.25. O, P, librigena NMV P78299; ventral and dorsal views (anterior at top of photographs), ×1.5. R, fixigena NMV P78300; dorsal view, ×1.25. S-V, Tropidocoryphinae gen. et sp. indet.; U from locality R26, remainder from approximately 300 m east of locality R25. S, cranidium NMV P78301; dorsal view, ×6. T, latex cast of external mould of pygidium NMV P78302; dorsal view, ×5. U, partly exfoliated cephalon NMV P59652, figured by Talent (1965b, pl. 25, fig. 4); dorsal view, ×3. V, pygidium NMV P78303; dorsal view, ×5.25. Except where otherwise stated, specimens are internal moulds.

by Sdzuy, in Moore 1959 are incorrect in this respect). Species of *T. (Dipleura)* differ from *T. lilydalensis* in lacking a vincular furrow on the cephalic doublure, and in having a more weakly segmented pygidium that is rounded posteriorly instead of pointed.

The cranidium from the underlying McIvor Sandstone described and figured by Talent (1965b, text-fig. 6) as belonging to the same species as pygidia from the Mount Ida Formation differs from the cephalon described above in the shape and convexity of the glabella and in the presence of indistinct 1p lobes.

Homalonotinae gen. et sp. indet. 2

Fig. 4I-L

MATERIAL: A cephalon and a pygidium from locality H25.

DESCRIPTION: Glabella narrows forwards at a constant rate and bears faint traces of 1p and 2p furrows; at the front it curves abruptly downwards into what appears to be a deep and sharply recessed preglabellar furrow. Axial furrow broad and shallow, except near front of glabella; paraglabellar area elliptical and extending forwards almost to point opposite middle of palpebral lobe. Anterior branch of facial suture converges gently and passes close to anterolateral extremity of glabella; lateral to eye, librigena descends vertically to lateral border, or is even inclined slightly inwards.

Pygidium longer than wide. Axis approximately one-half width of pygidium anteriorly; posteriorly it narrows, increases in convexity, and merges with strongly projecting post-axial region. There are at least 10 axial rings. Pleurae composed of 7 pleural ribs, anteriormost one divided into anterior and posterior bands by deep pleural furrow.

REMARKS: Amongst established Silurian and Devonian homalonotinid genera, the only one with a deep, sharply recessed preglabellar furrow seems to be *Homalonotus* itself (see Salter 1865, pl. 12, fig. 2; McLearn 1924, pl. 27, fig. 14). The present species is also not unlike *Homalonotus* in the shape of the glabella, the indistinct glabellar lobation, and the relatively well-defined paraglabellar areas. The pygidium is not as strongly segmented as in described species of *Homalonotus*, but is more like that of species such as *Burmeisteria (Digonus) clarkei* (Kozlowski 1923, pl. 1, figs. 14, 15).

Homalonotinae gen. et sp. indet. 3

Fig. 4M-R

MATERIAL: A librigena, a fixigena, a fragmentary thoracic segment, and 2 pygidia from localities R25 and R55.

REMARKS: The librigena has a gently convex central region separated from the less steeply inclined lateral border by a broad flexure that dies out posteriorly. The anterior branch of the facial suture curves in a broad arc to converge gradually with the outer margin of the cheek, so as to isolate an acute anterior projection on the librigena. The posterior portion on the librigenal doublure is narrow and steeply inclined; the anterior portion expands strongly forwards and near its outer edge bears a vincular furrow that dies out anteriorly. The pygidia differ from those of Homalonotinae gen. et sp. indet. 1 in that the posterior extremity is more acute and is slightly upturned; the axis is more convex (tr.) and does not appear to taper as strongly; the pleural rib furrows are weaker; and the vincular furrow is much stronger.

Family PHACOPIDAE Hawle & Corda 1847
Subfamily PHACOPINAE Hawle & Corda 1847

Genus Ananaspis Campbell 1967

TYPE SPECIES (by original designation): *Phacops fecundus* Barrande 1846 from the Kopanina Formation (Ludlovian), Koledník near Beroun, Czechoslovakia.

Ananaspis serrata (Foerste 1888)

Fig. 5A-P

1965b *Phacops* sp. cf. *P. serratus* Foerste; Talent, p. 50, pl. 26, figs 6-8.
1971 *"Phacops" serratus* Foerste; Sherwin, p. 83, pl. 1, figs 1-10, pl. 2, figs 1-5 (with full synonymy).
1977 *Paciphacops (Paciphacops) serratus* (Foerste); Campbell, p. 32.

TYPE MATERIAL: The neotype, selected by Sherwin (1971) is Australian Museum F27132, a partly exfoliated thorax and pygidium with disarticulated and inverted cephalon, figured by Sherwin (1971, pl. 1, figs 1, 5-7, 10), from the Upper Trilobite Bed (=Elmside Formation, early Gedinnian), near Bowning, New South Wales. The specimen on which Foerste based his species—an internal mould of the dorsal exoskeleton with disarticulated cephalon—is apparently lost.

OTHER MATERIAL: At least 50 cephala, 20 pygidia and an incomplete dorsal exoskeleton from localities R9, R24, R25, R30, R31, R54, approximately 300 m east of R25, and approximately 100 m south of R31.

REMARKS: The taxonomic importance of *Paciphacops (Paciphacops)* Maksimova 1972 to which the present species was assigned by Campbell (1977), has been questioned by Holloway (1980) who considered it to be at most a subgenus of *Ananaspis. Paciphacops* is apparently distinguished from *Ananaspis* (s.s.) only in the presence of perforate glabellar tubercles in large-eyed morphs and thickened sclera between the lenses in all small-eyed and most large-eyed morphs. Perforations in the glabellar tubercles have not been observed in the present material or in the topotypes, although the quality of the preservation is such that they would probably have been obliterated even if they were originally present. Eye dimorphism does not appear to be present in *A. serrata* but none of the specimens has thickened sclera. Thus we can see no morphological grounds for separating *A. serrata* at the subgeneric level from other members of *Ananaspis* (s.s.)

The most distinctive feature of *A. serrata* is the presence of axial spines on the occipital ring, thorax and pygidium. Similar spines (but not on the pygidium) are also developed in *A. claviger* (Haas 1969) from the Siegenian of Nevada and in some members of *Viaphacops* Maksimova 1972, although in the latter their presence on the thorax is extremely variable even amongst individuals from the same population, and this has led to the suggestion that they are a sexually dimorphic character (Eldredge 1973, Campbell 1977). There is some evidence that the axial spines in *A. serrata* are also dimorphic as they are present in only one of the pygidia from the Mount Ida Formation (Fig. 5N), and their absence in the other pygidia cannot in all cases be explained by breakage. The only thorax of *A. serrata* available to us from the Mount Ida is too poorly preserved to retain traces of axial spines (Fig. 5K). It is not possible to argue a strong case for dimorphism on the basis of the present material, but it is of interest to note that Etheridge & Mitchell (1895) suggested that *A. serrata* may be a sexual dimorph of their species *A. crossleii* which occurs in the same beds in the Yass Basin and lacks axial spines.

Our specimens of *A. serrata* are mostly larger than those figured by Sherwin (1971) but they are alike in the majority of characters. The main points of difference are as follows.

1. The only eye in which Sherwin was able to count the lenses had 14 dorsoventral lens files of up to five lenses each. The most complete lens count obtained for our material is from the specimen in Fig. 5F in which the eye contains 17 files with a maximum of five lenses per file, although the posteriormost file seems to contain only a single lens. In another specimen, however, the eyes contain at least six lenses in the longest file. There is also evidence of some variation in the overall size of the eye but the information is inadequate to determine if dimorphism is present.
2. The genal angle in at least some of the Mount Ida specimens is more pointed than it is in the topotypes (see Fig. 5H).
3. Most of the pygidia in our collection contain 7 axial rings and 5-6 pleural furrows, the same numbers given by Sherwin, but one of the largest (the only one with medial spines on the axial rings) has 9 axial rings and 7 or possibly 8 pleural furrows.

Sherwin (1971) stated that the cephalon of *A. serrata* from the Mount Ida Formation figured by Talent (1965b, pl. 26, figs 6, 8) differs from topotype cephala in that the glabella more strongly overhangs the anterior border and the medial portion of the vincular furrow is deeper, but we are unable to confirm this. Although Sherwin describes the medial portion of the vincular furrow as "very shallow", it is in fact moderately deep in the neotype, which retains the exoskeleton on the doublure (Sherwin 1971, pl. 1, fig. 10). Any slight difference in the depth of the furrow in Talent's specimen can be adequately accounted for by the fact that it is an internal mould.

The species *A. claviger* (Haas) referred to above has been compared with *A. serrata* by Sherwin (1971). In addition to the differences noted by him, *A. claviger* has eyes that are relatively larger than those of *A. serrata* and extend closer posteriorly to the axial furrow and the posterior border furrow; the sclera is thickened between the lenses; the intercalating ring is more distinctly separated medially from the remainder of the glabella; and the pygidium has a coarser tuberculate ornament and better defined pseudo-articulating half rings on segments 2 to 5 at least.

Several specimens of aphacopid have been obtained from mudstones within the Mount Ida Formation at locality R56. The cephalon bears genal spines and there are very long axial spines on the occipital ring and thorax but apparently not on the pygidium. The material is inadequate for meaningful comparison with *A. serrata*.

Family Dalmanitidae Vogdes 1890
Subfamily Dalmanitinae Vogdes 1890

Genus **Odontochile** Hawle & Corda 1847

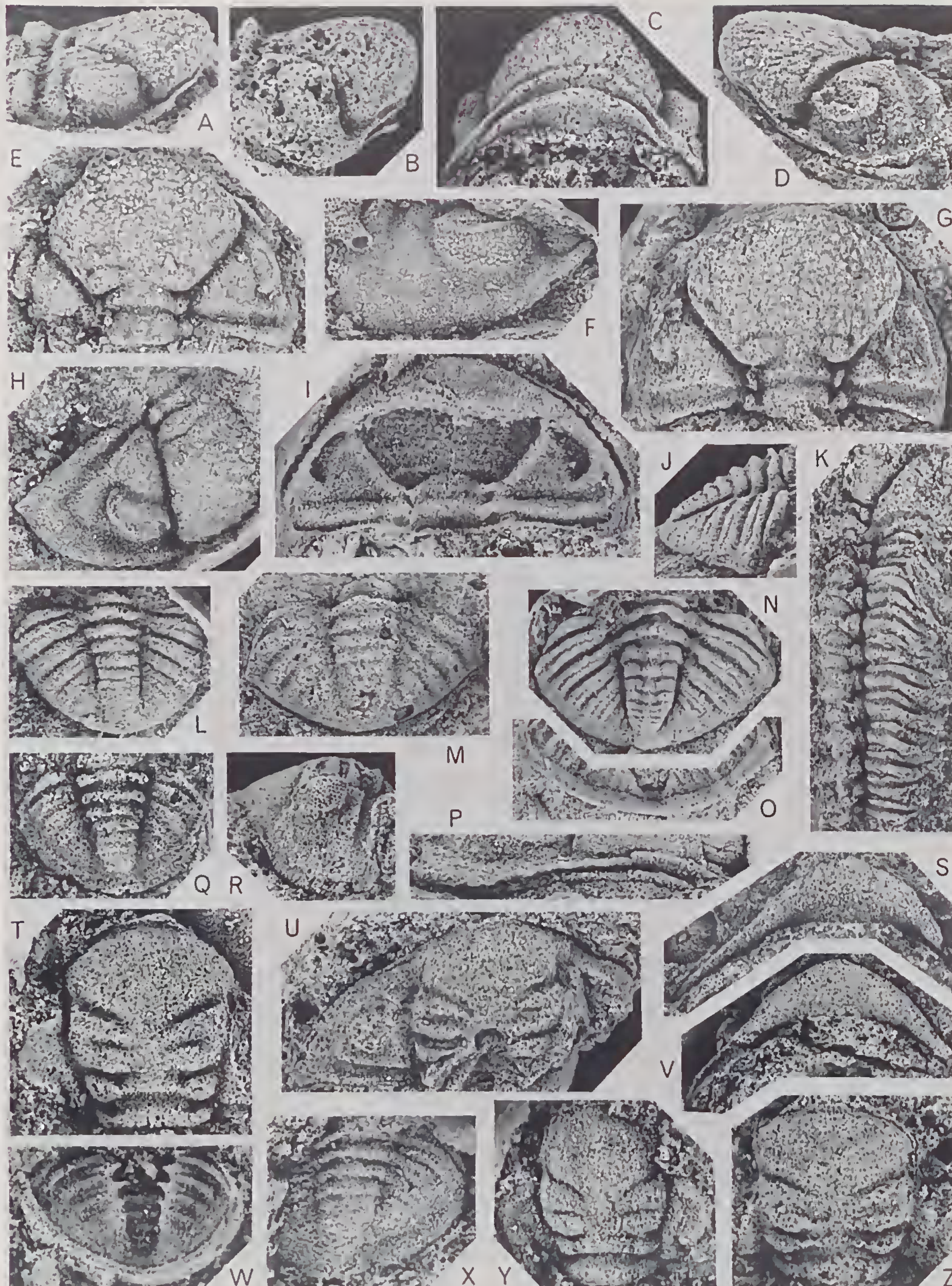
Type Species (ICZN Opinion 537 (1959)): *Asaphus hausmanni* Brongniart 1822 from the Dvorce-Prokop Limestone (Pragian), Prague district, Czechoslovakia.

Odontochile cf. formosa Gill 1948
Fig. 6M-U

cf. 1948b *Odontochile formosa* Gill; p. 20, figs 1, 2.
1965b Dalmanitidae gen. indet. B Talent, p. 51, pl. 27, fig. 1.
1965b Dalmanitidae gen. indet. C Talent, p. 51, pl. 27, figs 6, 8 (not pl. 27, fig. 7 = *Acastella?* sp.)

Material: At least 18 cephala, 35 pygidia, several fragmentary fixigenae and thoracic segments, and a detached visual surface from localities R20, R25, R31, between localities R25 and R30, approximately 300 m east of locality R25, and approximately 100 m south of locality R31.

Remarks: *Odontochile formosa* was erected by Gill (1948b) for specimens from the Humevale Formation (Early Devonian) at Kinglake West, Victoria, and has been redescribed and discussed by Jell & Holloway (in press) on the basis of material from a different stratigraphic horizon and locality. The present material is too fragmentary for a confident assignment to *O. formosa* but closely resembles that species in features such as the shape of the glabella and the proportions of the frontal lobe; the anterior border that is well-rounded in outline and lacks a medial process (see Fig. 6S); the number of lenses (14) in the longest dorsoventral file of the eye; the convex (tr.) eye platform that closely abuts the lateral border furrow (Fig. 6S); and the lack of a distinct inner flange on the pygidial doublure. The pygidia show considerable variation in the number of segments, smaller specimens having 10-12 axial rings and 11-12 or possibly 13 pleural furrows, whereas the largest has 17 axial rings and 15 pleural furrows. We have therefore been in some doubt as to whether more than one species is represented, although the difference in the size of the pygidia suggests that the variation is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due to ontogenetic changes. Specimens of *O. formosa* from the same area as the types show much less variation in the pygidial segmentation, even small specimens having 16-17 axial rings and 12-13 pleural furrows, whereas the largest have one or two more of each.

The presumed ontogenetic changes would account for the differences between the pygidia described by Talent (1965b) as Dalmanitidae gen. indet. B and Dalmanitidae gen. indet. C. It has already been pointed out by Shergold (1968) that the cranidium figured by Talent (1965b, pl. 27, fig. 7) as Dalmanitidae gen. indet. C. in fact belongs to an acastid.

Family Calmoniidae Delo 1935
Subfamily Acastinae Delo 1935

Remarks: We agree with Eldredge (1971) that Acastavinae Struve 1958 is a synonym of Acastinae.

Genus **Acastella** Reed 1925

Type Species (by original designation): *Phacops (Acaste) Downingiae* var. δ, *spinosus* Salter 1864 from the Upper Whitcliffe Beds (latest Ludlovian), Ludlow, Shropshire, England.

Acastella sp.

Fig. 5Q-Z

1965b Dalmanitidae gen. indet. C Talent, p. 51, pl. 27, fig. 7 (not pl. 27, figs. 6, 8 = *Odontochile* cf. *formosa* Gill 1948).

Material: At least 3 cephala, 15 cranidia and 13 pygidia from localities R25, R31, and approximately 100 m south of R31.

Description: Anterior margin of cephalon deflected gently forwards medially around front of glabella; maximum curvature at mid line. Glabella subquadrate, increasing in width anteriorly as far as 2p furrow, narrowing slightly to 3p furrow and thereafter expanding so that width at frontal lobe is almost equal to length (sag.). Occipital ring more strongly arched transversely than remainder of glabella, well rounded sagittally and exsagittally but with highest point close to posterior margin; occipital furrow deflected slightly backwards abaxially towards apodemal pit. 1p furrow directed obliquely backwards from axial furrow, becoming transverse adaxially and deflected slightly forwards proximally; 1p apodemal pit isolated from axial furrow and distinctly expanded at its inner end. 2p furrow shallower than 1p, transverse or slightly oblique, terminating relatively far from axial furrow distally. 3p furrow lying at about 60° to sagittal axis, expanding abaxially and abruptly shallowing just medial to axial furrow. Axial furrow rises gently between occipital ring and a point level with 2p furrow, thereafter falls steeply to outer end of 3p furrow and is very deep, but flattens out adjacent to frontal lobe and becomes indistinct (Fig. 5U). Palpebral lobe situated with δ opposite 2p furrow and ϵ close to posterior border furrow; anterior branch of facial suture converges slightly between γ and β. Incomplete eye preserved on specimen in Fig. 5R has at least 6 lenses in the longest dorsoventral file. Lateral border indistinctly separated from central part of cheek, which rises steeply adaxially so that recessed region below eye is vertical. Posterior border short (exsag.) but prominent, expanding slightly abaxially; posterior border furrow deep proximally but abruptly dying out distally. Posterior edge of cephalon curves backwards distally, indicating that a genal spine was probably present although it is not preserved (Fig. 5R, U). Medial part of cephalic doublure convex (sag.) anteriorly and concave behind; hypostomal suture transverse or gently convex forwards. Lateral part of doublure narrows towards genal angle and curves sharply upwards and outwards towards inner margin which is almost in contact with inner surface of cheek.

Posterior margin of pygidium of almost uniform curvature in dorsal view, deflected slightly upwards medially in posterior view. Axis composed of 6-7 axial rings; posterior to third ring, rate of taper of axis decreases slightly, apodemes abruptly decrease in size, and axial rings are more flattened (sag., exsag.). Pleurae curve steeply downwards abaxially to a gently inclined border. There are 3-4 successively shallower pleural furrows and 2-3 weak interpleural furrows. Doublure with a narrow, subhorizontal outer part and an almost

Fig. 5—A-P *Ananaspis serrata* (Foerste 1888); B, C, from locality R24; K from 100 m south of locality R31; M from locality R25; remainder from 300 m east of locality R25. A, E, latex cast of external mould of cephalon NMV P78304; lateral and dorsal views, ×2. B, C, cephalon NMV P78305; lateral and anteroventral views, ×2.5. D, G, cephalon NMV P78306; lateral and dorsal views, ×2. F, latex cast of external mould of cheek NMV P78307; dorsolateral view, ×2.5. H, latex cast of external mould of cephalon NMV P78308; oblique view, ×2.25. I, latex cast of cephalic mould NMV P78309; ventral view, ×2. J, N, O, pygidium NMV P78310, ×2; J, N, latex cast of external mould in lateral and dorsal views; O, latex cast of counterpart mould in ventral view. K, incomplete cephalon and thorax NMV P78311; dorsolateral view, ×1.75. L, latex cast of external mould of pygidium NMV P78312; dorsal view, ×3. M, pygidium NMV P78313; dorsal view, ×1.75. P, latex cast of external mould of cephalon NMV P78314; anterior border and doublure in anterolateral view showing vincular furrow, ×3. Q-Z, *Acastella* sp; Q from locality R31; T from 100 m south of locality R31; remainder from locality R25. Q, pygidium NMV P78315; dorsal view, ×3.75. R, U, cephalon NMV P78316; lateral and dorsal views, ×2.25. S, cephalic doublure NMV P78317; ventral view, ×2.75. T, cranidium NMV P78318; dorsal view, ×3. V, cephalic doublure NMV P78319; ventral view, ×2.25. W, latex cast of pygidial mould NMV P78320; ventral view, ×2.75. X, latex cast of external mould of pygidium NMV P78321; dorsal view, ×3.5. Y, latex cast of external mould of cranidium NMV P78322; dorsal view, ×3.5. Z, cranidium NMV P78323; dorsal view, ×3.75. Unless otherwise stated, specimens are internal moulds.

vertical inner flange, the junction between the two being subangular.

REMARKS: There is some variation between specimens in the width of the glabella at the frontal lobe relative to that at the 2p furrow, the width (tr.) of the glabellar furrows, and the width of the pygidial pleurae as compared with that of the axis. However, in the lack of convincing evidence to the contrary, we assume that only a single species is represented.

Shergold (1968, p. 21) suggested that the incomplete cranidium from the Mount Ida Formation figured by Talent (1965b, pl. 27, fig. 7) belongs to *Acaste*. We prefer to assign the present material (as well as that of Talent) to *Acastella* because of the rather pointed anterior cephalic outline (as shown by the shape of the front of the doublure; Fig. 5S, V); because genal spines were probably present; and because in some of the cranidia (Fig. 5T, Z) it can be seen that the anterior branch of the facial suture diverges from the preglabellar furrow medially and joins at an obtuse angle, isolating a small, triangular portion of the cranidium in front of the glabella. This last feature is present in most previously described species of *Acastella* and is particularly well develolped in *A. tiro* R. & E. Richter (1954, pl. 5, fig. 73d).

The only other acastids recorded from Australia are the species *Acastella frontosa* and *Acaste longisulcata* described by Shergold (1968) from the Early Devonian Humevale Formation near Lilydale, Victoria. *A. frontosa* differs from the present material in having a larger subtriangular portion of the cranidium enclosed by the facial suture in front of the glabella, a relatively longer glabella, and a more strongly segmented pygidium with relatively broader pleural regions. The holotype of *A. longisulcata* is an internal mould of a pygidium figured by Chapman (1915, pl. 15, fig. 15) as *Phacops crossleii* Etheridge & Mitchell 1896. This pygidium does in fact belong to a phacopid, as indicated by the form of the articulating facets and the slight forward deflection of the axial rings towards their distal ends. This deflection of the axial rings is caused by the pattern of insertion of the appendage muscles (see Campbell 1975, fig. 1, pl. A, fig. 6). The other specimens figured by Shergold as *A. longisulcata* are acastid.

Family LICHIDAE Hawle & Corda 1847
Subfamily CERATARGINAE Tripp 1957

Genus **Acanthopyge** Hawle & Corda 1847
Subgenus **Acanthopyge (Lobopyge)** Pribyl & Erben 1952

TYPE SPECIES (by original designation): *Lichas Branikensis* Barrande 1872 from the Dvorce-Prokop Limestone (Pragian) at Prague, Czechoslovakia.

REMARKS: This taxon was considered by Tripp (*in* Moore 1959) to be a synonym of *Acanthopyge* (s.s.) but we accept the arguments of Chatterton, Johnson & Campbell (1979) for regarding it as a separate subgenus.

Acanthopyge (Lobopyge) sp.

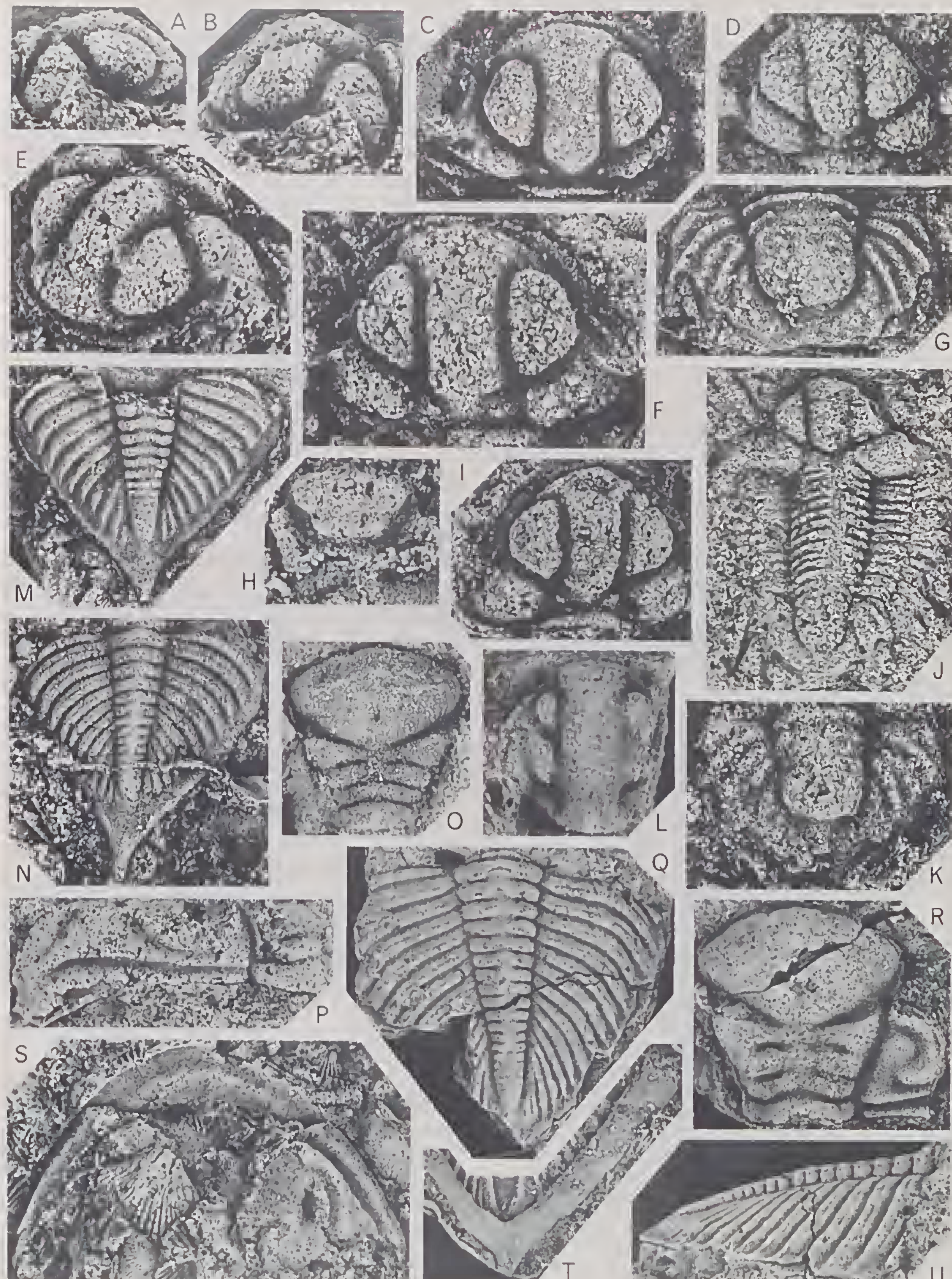
Fig. 6A-K

MATERIAL: At least 20 cranidia, a hypostome, 3 pygidia and an almost complete dorsal exoskeleton from locality R25.

DESCRIPTION: A pair of large tubercles is present on the depressed median part of the 1p lobe but there appears to be no definite arrangement of tubercles on other parts of the cranidium. Posterolateral cranidial lobe separated from median part of 1p lobe by broad longitudinal furrow, not separated from remainder of fixigena abaxially, or else bounded only by a faint vestige of a furrow. Median glabellar lobe rises steeply from median part of 1p lobe to reach a maximum height opposite front of palpebral lobe, subparallel-sided or even narrowing slightly forwards before expanding around front of anterolateral cranidial lobe; anterolateral extremities of median lobe acute and depressed. Pit-like depressions present where longitudinal furrow meets axial and 1p furrows. Palpebral lobe rising steeply from cheek and curving outwards distally, much lower than posterolateral cranidial lobe. Gentle eye ridge runs from front of palpebral lobe towards junction of axial and longitudinal furrows.

Anterior margin of hypostome gently convex. Middle body 1.6 times as wide as long, lateral margin notched at outer end of middle furrow; distinctly swollen maculae situated at lateral extremities of posterior lobe.

Fig. 6—A-K, *Acanthopyge (Lobopyge)* sp., from locality R25. A, cranidium NMV P78324; lateral view, ×5.5. B, E, cranidium NMV P78325; lateral and oblique views, ×7. C, cranidium NMV P78326; dorsal view, ×5. D, latex cast of external mould of cranidium NMV P78327; dorsal view, ×4.5. F, cranidium NMV P78328; dorsal view, ×6. G, pygidium NMV P78329; dorsal view, ×3.75. H, hypostome NMV P78330; ventral view, ×6.25. I, cranidium NMV P78331; dorsal view, ×5. J, almost complete dorsal exoskeleton NMV P78332; dorsal view, ×3.25. K, pygidium NMV P78333; dorsal view, ×4.5. L, *Leonaspis* sp., from 300 m east of locality R25. Cranidium NMV P78334; dorsal view, ×3. M-U, *Odontochile* cf. *formosa* Gill 1948; M, N, S, from locality R25; O, Q, R, U, from locality R31; P from between localities R25 and R30; T from 100 m south of locality R31. M, pygidium NMV P78335; dorsal view, ×2.25. N, latex cast of external mould of pygidium NMV P78336; dorsal view, ×3.5. O, latex cast of external mould of glabella NMV P78337; dorsal view, ×2.5. P, incomplete cranidium NMV P78338; dorsolateral view, ×1.75. Q, U, pygidium NMV P78339; dorsal and lateral views, ×0.9. R, cranidium NMV P78340; dorsal view, ×2. S, cephalon with glabella and anterior border broken off to reveal external mould of doublure NMV P78341; dorsal view, ×1.5. T, latex cast of pygidial mould NMV P78342; ventral view, ×1. Unless otherwise stated, specimens are internal moulds.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Thorax composed of 11 segments. Axis strongly rounded (tr.), subparallel sided as far as sixth or seventh segment and thereafter narrowing gently. Pleurae with a gently convex (tr.) articulated portion approximately one-half the width of the axis and with downturned distal spines curving backwards on more posterior segments.

Pygidial axis as wide anteriorly as long (sag.), narrowing only slightly backwards and broadly rounded posteriorly. Anteriormost axial ring short (sag., exsag.) and prominent, turned slightly backwards abaxially. Second ring bears a large tubercle distally and another closer to midline; between these tubercles the ring is similar in form to first ring except that it is lower and turned more strongly backwards; medial part of ring is very faint. Second ring furrow curves downwards abaxially into a weak apodeme. Third ring vaguely defined, apparently with a row of tubercles. Posterior pleural bands on first and second segments more convex than anterior bands, anterior band on second segment wider distally than posterior band. First marginal spine diverging at about 10° to sagittal axis, second spine directed straight backwards, third spine poorly preserved but situated close to sagittal axis. Pleurae steeply inclined behind axis, with a gently convex postaxial ridge bounded laterally by a shallow furrow. Doublure narrow, flattened, and bearing concentric terrace lines.

REMARKS: Despite the poor preservation of the material it is possible to distinguish this species from the other species of *A. (Lobopyge)* that have been described from the Early Devonian of southeastern Australia. In *A. (L.) australiformis* Chatterton, Johnson & Campbell 1979 and *A. (L.) sinuata* (Ratte 1886), both from the Garra Formation near Wellington, New South Wales, the median glabellar lobe rises more gently from the 1p lobe, the palpebral lobes are relatively higher, and the pygidial axis is longer and narrower. In addition, the anterior margin of the hypostome in *A. (L.) australiformis* is more convex and the second pair of marginal spines on the pygidium curve slightly inwards distally, while *A. (L.) sinuata* has a definite pattern of large tubercles on the cranidium, the anterior pleural bands on the pygidium are relatively shorter (exsag.) and the anteriormost marginal spines on the pygidium are more divergent. *A. (L.) australis* (McCoy 1876) from the Humevale Formation near Lilydale, Victoria is in need of revision, but it has a relatively longer pygidial axis with a posterior lobe that is distinctly inflated and bears a number of large tubercles, and the pleural region behind the second segment is larger (Gill 1939, pl. 5, fig. 1). The fragmentary pygidia of *A. (Lobopyge)* described by Chatterton, Johnson & Campbell (1979, pl. 109, figs 22, 23) from the Warroo Limestone near Yass, New South Wales are more weakly tuberculate than those from the Mount Ida Formation and the anterior marginal spines are more divergent, at least proximally.

Amongst overseas species, the closest resemblance is with *A. (L.) consanguinea* (Clarke 1894) from the Early Devonian of New York, *A. (L.) richteri* (Vanek 1959) from the Lochkovian of Czechoslovakia, and *A. (L.) pragensis* (Boucek 1933) from the Pridolian or Lochkovian of Czechoslovakia. It is not possible definitely to distinguish the Mount Ida species from *A. (L.) richteri* or *A. (L.) pragensis* on the basis of published illustrations, but *A. (L.) consanguinea* has a distinctive arrangement of larger tubercles on the cranidium, and the anterior margin of the hypostome is more arcuate (Whittington 1956, pl. 131). Chatterton, Johnson & Campbell (1979) included *consanguinea* in *Acanthopyge (Acanthopyge)*, but on the basis of pygidial characters it clearly belongs to *Lobopyge*.

Family ODONTOPLEURIDAE Burmeister 1843
Subfamily ODONTOPLEURINAE Burmeister 1843

Genus **Leonaspis** R. & E. Richter 1917

TYPE SPECIES (by original designation): *Odontopleura Leonhardi* Barrande 1846 from the Kopanina Formation (Ludlovian) at Koledník near Beroun, Czechoslovakia.

Leonaspis sp.

Fig. 6L

MATERIAL: A cranidium from approximately 300 m east of locality R25.

REMARKS: The most distinctive features of this cranidium are a relatively short (sag.) occipital ring with a large median tubercle or spine situated close to the posterior margin; a strongly inflated median glabellar lobe; relatively wide fixigenae; a facial suture that runs directly forwards in front of the eye before curving gently inwards; and an ornament of moderately coarse granules. These features are also characteristic of *L. rattei* (Etheridge & Mitchell 1896) from the Ludlovian-Gedinnian of the Yass Basin, New South Wales (see Chatterton 1971, pl. 22, figs. 8-14) but the present material is inadequate for meaningful comparison with that species.

ACKNOWLEDGEMENTS

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